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SOME FEATURES OF IMPORTANT TAXA OF SOIL MESOFAUNA IN AN AFRO-MEDITERRANEAN COASTAL DESERT.
VI.- ON THE ANALYSIS OF SOIL FAUNA DATA BY SOME ORDINATION METHODS.

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ABSTRACT

Data sets on populations of soil fauna and soil factors from two desert regions in Egypt were analyzed by some widely used ordination methods namely principal components analysis , correspondence analysis , detrended correspondence analysis and spectral mapping in order to identify the specific validity of each method to the concept of characterizing sites by patterns of soil fauna . These ordination methods were compared in accordance to their relative advantages to the problem under consideration.

Correspondence analysis and spectral mapping gave the most satisfactory results.

The study has also shown that concordant results obtained from a number of different methods, applied to the same data set, would indicate with more certainty the value of certain taxa in characterizing a site .

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1.Introduction

Natural biological processes occurring in the soil are an important factor contributing to the increase in food production capacity through the possibility of manipulating the "actors"of these processes towards higher levels of soil fertility. The principal"actors"in biological processes of soil fertility are its flora and fauna. A substantial body of knowledge is already available on the role of soil flora (Bacteria and Fungi) in several tropical countries (Rosswall) [22]). Much less is notoriously known on the role of soil fauna, which is much more varied and diverse, and occupying more than one trophic level in the soil system. In many cases, not even the existing species or higher taxa are known .

Certainly no management programme could be possibly recommended without knowing these"actors"and the factors controlling their distribution (soil type, climate,vegetation cover, land use,etc).

Different techniques of multivariate analysis should allow for locating indicator species (and higher taxa) of soil fauna occurring in various sites, and grouping them in accordance with the environmental factors prevailing in their sites of occurrence. It is assumed that the faunistic assemblages present in a site respond to the totality of its environmental parameters, and therefore this assemblage is an indicator of the summed and interacting effects of these parameters on the fauna. Special indicator species, by either their abundance, or their rarity, could also be identified. Pest species, and factors leading to their proliferation, could also be identified during the evolution of agro-ecosystems in time and in space.

Previous attempts to study simultaneously community and environmental variations considered canonical correlation analysis (CCA) and correspondence analysis (CA) (Austin [2], Cassie *et al*

[8], Cassie [7], Gauch *et al* [12], Gittins [14]). Greenacre [6] gave an example of the use of categorical environmental data for interpreting fauna frequency data. In this example, environmental crude categorical data were coded as a logical indicator and categories were represented on the correspondence analysis;, ordination graphs to assist in the interpretation.

The objective of this study is : 1) to analyze a known soil fauna data set by some ordination methods and to compare between them in accordance to their relative advantages to the problem under consideration , 2) to verify the possibility of plausibly relating faunistic assemblages to environmental characteristics of the sites. The comparison was conducted using real data sets (Tables 1 and 2) from the regions of Mariut and Assiut in Egypt where a substantial body of knowledge about their faunistic assemblages and soil properties is available, which helps in validating and examining the results produced by the various methods.

2.Material and methods

2. 1. Methodology

In this study four multivariate analysis methods were utilized : the principal components analysis (PCA),the correspondence analysis (CA), the detrended correspondence analysis (DCA) and spectral mapping(SM). In all of them the data analyzed can be the raw data or the data transgenerated (i.e.by taking their logarithms, square roots, arcsines, etc).

The principal components analysis is the oldest of them and is closely related to the multivariate normal distribution (Hotelling [18], Dagnelie [10]). Its transformation matrix is a function of the original data matrix, either raw or transgenerated (Pielou [21]). In the three other methods, the original data (raw or transgenerated) matrix is somewhat standardized beforehand. Principal Conponents Analysis can be viewed as a technique for projecting a multidimensional cloud of points into a space of fewer dimensions. Successive orthogonal axes are derived using rigid rotation which maximize the variance accounted for. Therefore the distortion of distances between points is

minimized when projected into fewer dimensions. This dimensionality reduction facilitates comprehension of the relationship of the points to one another.

Correspondence Analysis provides the simultaneous ordinations of rows and columns of the data matrix. Its difference from Principal Components Analysis lies in the choice of a special metric, the metric of Chi-square distances. In the correspondence analysis method, the new data matrix obtained by the standardization of the original one corresponds to the probabilities of the couples "object-descriptor", and the tansformation matrix is a function of the Chi square distance between the row profiles (Benzecri [4], Escovier-Cordier [11] The detrended correspondence analysis is an improvement of the CA aiming at making the axis not only uncorrelated but independent, and at eliminating the arch effect caused by a strong relation between the second and some of the other axes to the first axis (Hill *et al* [17]).

Spectral Mapping has been developed into a data analysls procedure by Lewi [19]. The idea is based on row centring of the data table for size or magnitude correction as described by Cronback and Gleser [9]. The row centered data matrix is obtained by computing expectations row by row and subtracting from the elements of the corresponding row.

Another way of treating the considered problem would be to establish a model such as the Gaussian model or one of the Leo Goodman's models, and to estimate the relevant parameters. The analysis of the considered problem would also have been possible with Canonical Correspondence Analysis (ter Break [5]), however our objective in this study was to examine the spacific validity of some selected ordination techniques to the problem under consideration.

2.2.Data sets

Sets of data (Tables 1 & 2) from two regions of Egypt namely Mariut and Wadi Assiuty were chosen for this study. These are sites of minimum human impact and would therefore better show the effect of natural environmental factors .

2.2.1.The Mariut data set

Soil mesofauna (i.e. larger than 1 mm) was sampled by the sieving method from under four shrub of species *(Lygos raetam Thymelaea hirsute, Lycium shawii, and Jasonia candicans)* growing at Gharbaniat , 53 km w of Alexandria , Egypt . Further details about the Mariut sites are given in (Ghabbour *et al* [13]). This particular data set was chosen for this comparison because it represents the result of two and half years of continuous and systematic monthly sampling . It has been examined from several aspects singly or in combination with data collected similarly from nearby sites. In addition to the actual sampling programme, the area of Mariut, from which the samples were taken, is an area of training for students for several decades and scores of geological, climatic, pedological and vegetational studies have been carried out there. For these reasons, it is possible to assess the value of the results given by the various ordination methods against first hand field experience of the Mariut environment and its known characteristics .

2.2.2.The Wadi Assiuty data set

This set of data is derived from a study of the soil fauna at the Wadi El-Assiuty/Wadi Habib area , 12 km E of Assiut , since 1983, as the area is proposed to become a center for the propagation of endangered plant and animal species from the arid regions of Egypt (Ali[1]). The soil fauna was sampled seasonally. Samplinq was by the pitfall trap method, so date refer to abundance and not density. The data from Wadi Assiuty belong to a site in Upper Egypt which is also a desert site but in an almost rainless environment. It belongs to the hyper-arid desert climate. The environmental parameters (i.e. soil factors) pertaining to the sites of both Mariut and Wadi Assiuty regions are given in Table 2.3. Treatment of data. and extracbron methods Given the wide variation in sampling and in level of taxonomic identification manipulate the data as follows :

Table (1): percentage population Denslty of Taxa of soil Mesofauna At Gharbania And wadl Assiuty Bxplanation of sites:
A=WADI ASSIUTY 1, B= WADI ASSIUTY 2 ; C= LYGOS WINDWARD, D=LYEEWARD, E= THYMELAEA WINAWARD, F THYMELA LEE-WARD, G= LYCIUM WINDWARD, H= LYCIUM LEEWARD, I= JASONIA, J=THYMELAEA AT SOUTH GHAPBANIAT.

SITE / TAXON	A	B	C	D	E	F	G	H	I	J
1. Gcophi lomorpha	0	0	0.10	0.21	0.22	0.05	0	0	0.79	0
2. Hymcnoptera	73.16	92.95	0.43	2.18	1.16	0.78	0.64	0.62	0.58	5.81
3. Lepidoptara	6.48	0.16	0.75	0.77	0	0.31	1.48	0.42	1.70	1.06
4. Diptera	2.26	0	0.80	0.50	1.01	0.96	3.46	1.50	2.70	2.54
5. Thysanura	0	0	0	0	0	0	0	0	0	0.42
6. Ncuroptera	0.23	2.73	3.33	2.48	3.69	8.13	4.16	2.95	4.24	5.95
7. Scorpions	0	0.08	0.10	0.02	0	0.03	0	0	0	0.07
8. Pseudoscorpions	0	0	0.23	0.13	0.07	0.68	0	0.33	0	0
9. Orthoptera	0.44	0	0	0	0	0	0	0	0	0
10. Dictyoptera	0	0	37.03	24.22	21.49	37.67	44.60	59.39	60.60	20.35
11. Isopoda	0	0	12.52	10.03	5.35	2.70	8.19	1.37	1.21	6.48
12. Scolopendra	0	0	0.28	0.07	0.14	0	0.28	0	0	0
13. Araneida	0	0	1.36	0.50	2.17	1.01	1.06	0.54	3.53	2.18
14. Hemiptera	0.44	0	0.10	0.82	2.97	3.43	0.49	0.17	0.87	4.51
15. Ixodidac	0	1.93	0	0	0	0	0	0	0	0.21
16. Coleoptera	14.48	2.49	42.98	58.06	61.72	44.24	35.64	32.71	23.78	50.36
17. Other orders	1.52	0.04	0	0	0	0	0	0	0	4.93

Table II. Soil Characteristics of Sites Shown Table I. (Explanation of sites As In Table I)

SITE / Soil characteristics	A	B	C	D	E	F	G	H	I	J
1. soil temperature (c)	30.2	30.3	20.2	20.2	20.2	20.2	20.2	20.2	20.0	19.5
2. soil moisture (\ )	0.90	0.95	2.40	2.40	2.32	2.32	2.65	2.65	1.56	2.68
3. salinity (mmhos. cm -1).	0.61	0.34	1.84	1.55	1.48	1.48	1.83	1.96	3.46	0.22
4. P H.	7.18	8.49	8.40	8.40	8.37	8.42	8.41	8.37	8.54	8.60
5. Sand (/)	85.90	91.92	88.50	87.9	88.6	89.9	86.9	88.5	87.5	86.0
6. Organic matter	0.08	0.16	1.41	1.08	1.64	1.88	0.70	0.81	0.50	0.34
7. N (mg/100g)	0.014	0.014	0.019	0.019	0.018	0.017	0.015	0.014	0.015	0,016
8. P (mg/ 100g)	7.88	14.18	40.67	45.20	41.29	37.00	27.25	31.00	29.50	20.19
9. caco3 (/)	20.97	22.05	88.2	76.1	86.90	82.30	88.50	85.10	85.00	74.00

Soil temperature : yearly average at -5 cm
Soil moisture : Yealy average
Soilnity : condctivity

1. When incorporating taxonomical data from different sites and by different authors, data from lower taxa (species,genera, had to be aggregated into higher taxa (families, orders) in order to avoid large and unnecessary discrepancies among sites which would, if retained, show gross unrealistic differences among sites, thereby masking whatever resemblances they might have among themselves.

2. For the purposes of the present study,restricted to data from two Egyptian desert regions, data resulting from monthly or seasonal sampling of the soil fauna had to be averaged to yearly data, again to simplify the basis of comparisons.

3. Since the fauna population data from the two regions were variably expressed as density for some and abundance for others these data were transformed into percentages.

These manipulations aim at making the data sets relatively more comparable, therefore allowing reasonable comparisons among the methods used.

Computations were made on IBM system VM/370 with a 4341 processor using the IBM Multivariate Data Analysis Program [20] and DECORANA [16] program of Cornell University.

3. Results and discussions

The results expounded herein (Figs.1 to 6) are those serving the purpose of the present study, which is showing the relative advantage of each method to the problem under consideration. In order to elucidate the specific validity of the different types of data analyses to the type of data under study, results given by any particular method were compared with biological and ecological prior knowledge one has of the sites and the original data.

All methods have clearly separated Wadi Assiuty sites from all other sites of Mariut region. The characterist., cs of the sites, in terms of soil fauna taxa and soil factors, could be summarized as follows :

Wadi Assiutyl and Wadi Assiuty2 are characterized mainly by Hymenoptera(ants), Orthoptera, Ixodidae and Lepidoptera (Figs. 4 L 5). On the other hand, the soil factors that characterize these sites are essentially soil temperature, pH and sand (Fig. 3).

Differentiation of the sites of Mariut region was somewhat less evident to discern . The only site that is relatively well separated from the others in this region is The melaea at south Gharbaniat (Figs. 3&6) which is a degraded free grazing site in the inland depression . This site is characterized by Thysanura,

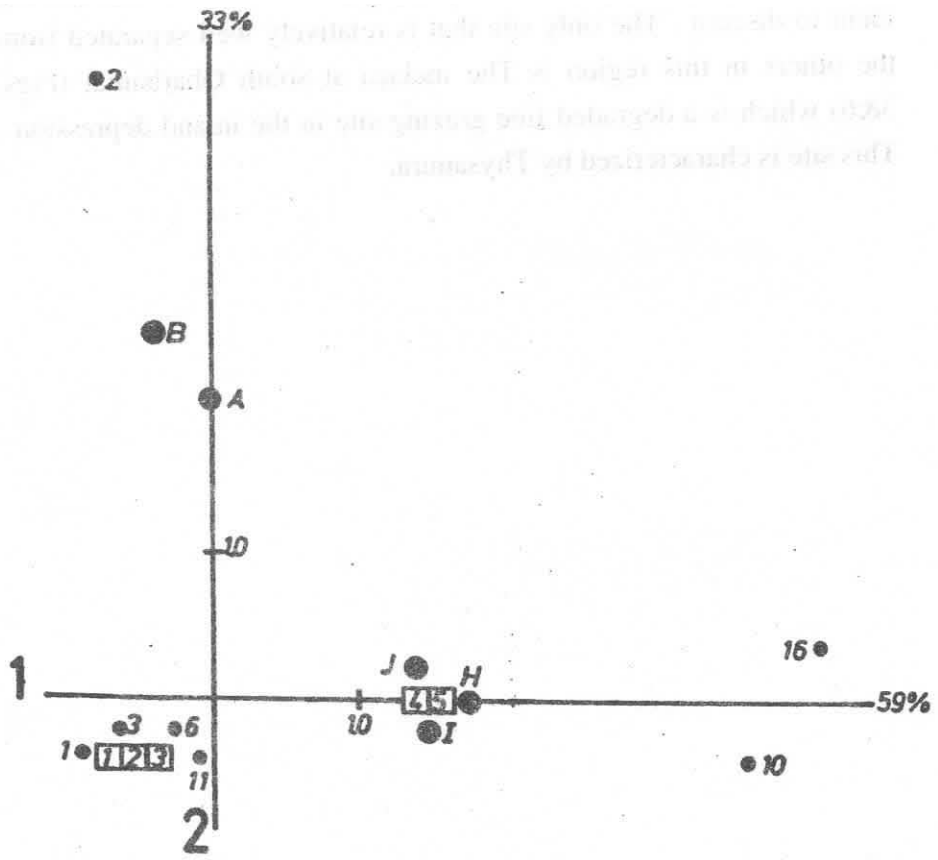

Fig.1. Principal components analysis ordination of the data set of table 1. Explanation of symbols: small dots, taxa, numbers 1-17; large dots, sites, letters A-J (squares represent superimposed points, sq.1: points 4,13,14 ; sq.2: points 5,7,8,12,17 ; sq.3: points 9,15; sq.4: points C,F,G ; sq.5: points D, E). Sites and taxa names are given in the legend of table 1. Numbers below the drawing refer respectively to the variance accounted for by the first and second factorial axes and the residual variance, all amounting to 1.000.

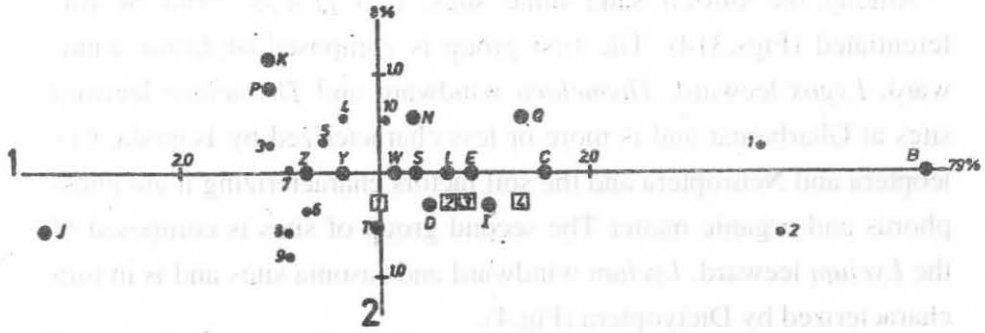

Fig.2. Spectral mapping ordination of the combined data set of tables 1&2. Explanation of symbols : large dots, taxa, letters A-Q, soil factors, letters R-Z ; small dots, sites, numbers 1lO.(squares represent superimposed points, sq.l: points F,M ; sq.2: points A,H,U ; sq.3: points G,V,X ; sq.4: points O, R). Letters A-Q correspond to taxa 1-17 in table 1 and letters R-z correspond to soil factors 1-9 in table 2 and numbers 1-10 correspond to sites A-J in table 1. Numbers below the drawing refer respectively to the variance accounted for by the first and second factorial axes and the residual variance, all amounting to 1.

Hemiptera and Scorpions whereas its characteristic soil factor is soil moisture (Fig.3).

Among the littoral sand dune sites, two groups could be differentiated (Figs.314). The first group is composed of *Lygos* windward, *Lygos* leeward, *Thymelaea* windward and *Thymelaea* leeward sites at Gharbaniat and is more or less characterized by Isopoda, Coleoptera and Neuroptera and the soil factors characterizing it are phosphorus and organic matter The second group of sites is composed of the *Lycium* leeward, *Lycium* windward and Jasonia sites and is in turn characterized by Dictyoptera (Fig.4).

These site characteristics, either by soil fauna population or by soil factors are consistent with prior knowledge and experience about the ten sites . The separation of the sand dune sites into two main groups reflects the fact that shrubs which were sampled for soil fauna occupy different positions on the dune, and are of different sizes. While each shrub species repre. sents a characteristic case by itself, yet there are certain obvious and other more subtle similarities between some of them, differentiating them from some others. According to the ordination, one group of shrubs is composed of *Lygos* and *Thymelaea*, both large shrubs with a diameter of canopy exceeding 1 meter. Lygos is on the steep land ward slope while *Thymelaea* occupies the crest of the dune. Both are therefore characteristic of old and deep soils, of relatively higher fertility (*phosphorus* and *organic* matter). The second group is composed of Lyceum and Jasonia shrubs, both small in size with diameters of canopy rarely reaching 1 meter. *Lycium* occupies the seaward gently sloping side of the dune, exposed to salt spray, while *Jasonia* grows in rock cracks where some sand is accumulated. Apparently both shrubs serve as temporary shelters for soil fauna but not as permanent habitat. Thus position on the dune and size of shrub were the determinant factors in the ordination. At the same time, the proximity of the South Gharbaniat site to the Wadi Assiuty sites (Figs. 3&6) reflects the fact that the former site belongs to the accentuated arid Mediterranean climate (Ayyed *et al* [3]), although it is geographically much nearer to the littoral dune sites

than to the Wadi Assiuty sites which lie within the hyper-arid bioclimatic province. The other sites of Gharbaniat are on the littoral sand dune and belong to the attenuated arid Mediterranean climatet Ayyed *et al* [31). Therefore, the first factorial axis in Figs 3 and 6 can be clearly associated with a biocli-matic gradient.

3.1.comparative evaluation of the methods

In judging the validity of the results given by a particular method, for the purpose of comparison, associations and relationships, discerned by a method should be in accordance with prior experience and common sense and should show these associations strongly enough to be convincing.

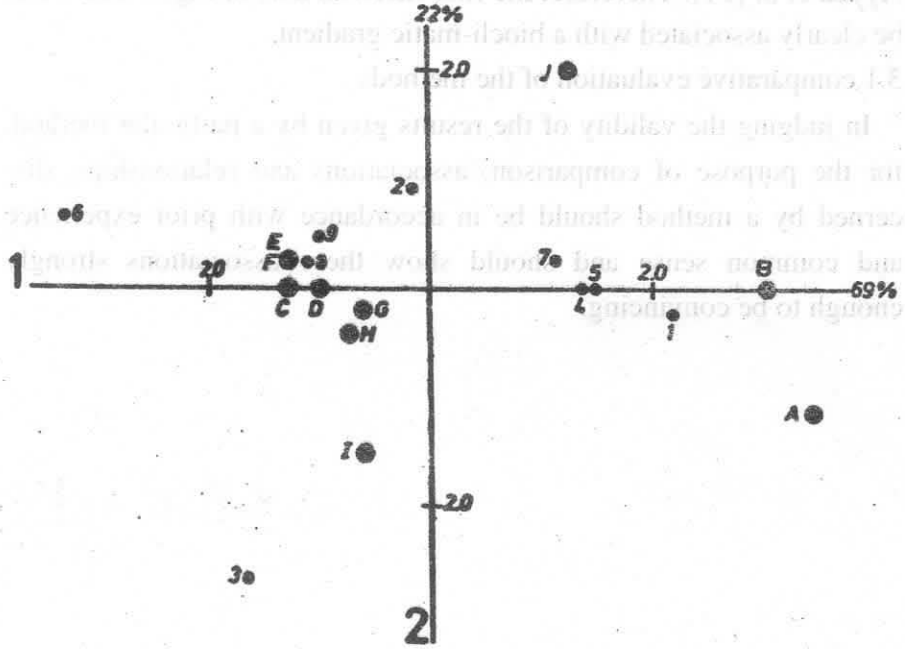

Fig.3. Spectral mapping ordination of the data set of table 2. Explanation of symbols: small dots, soil factors, numbers 1-9; large dots, sites, letters A-J. Site and soil factor names are given in tables 1&2. Numbers below the drawing refer respectively to the variance accounted for by the first and second factorial axes and the residual variance, all amounting to 1.000.

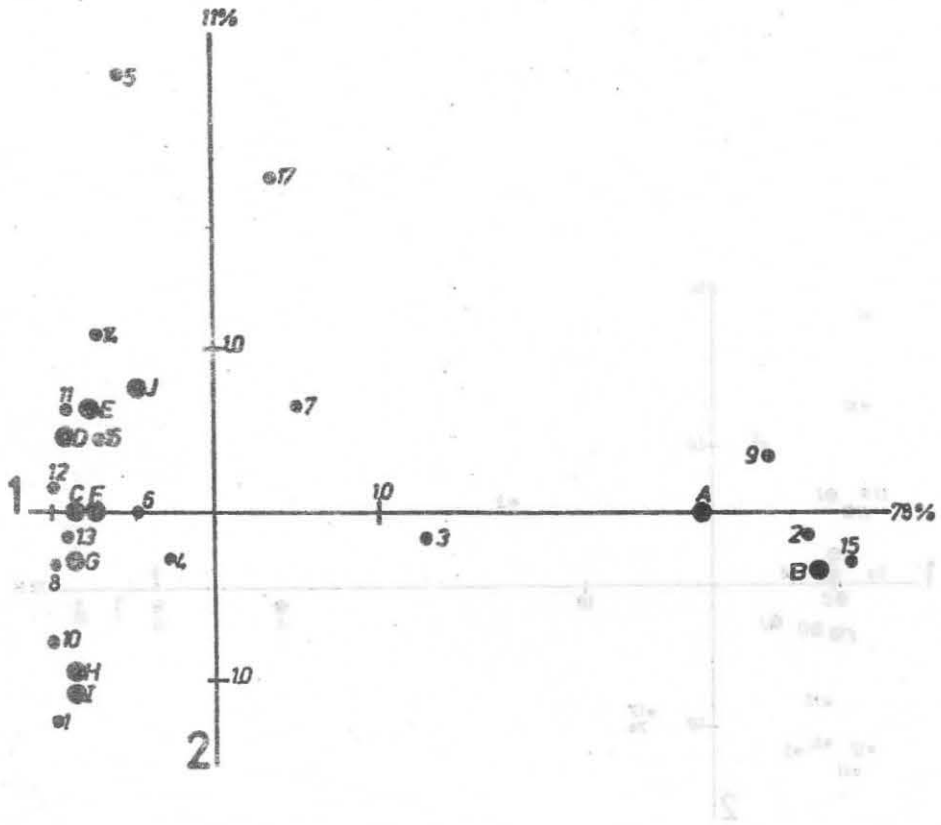

Fig. 4. Correspondence analysis ordination of the data set of table1. (For explanation of symbols, see legend of Fig.1).

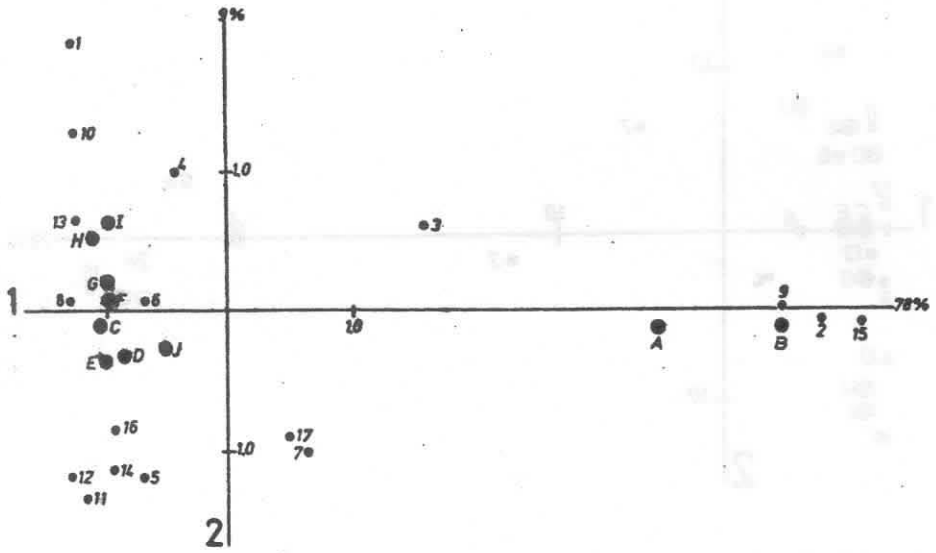

Fig.5. Detrended correspondence analysis ordination of the data set of table 1. (For explanation of symbols, see legend of Fig.1).

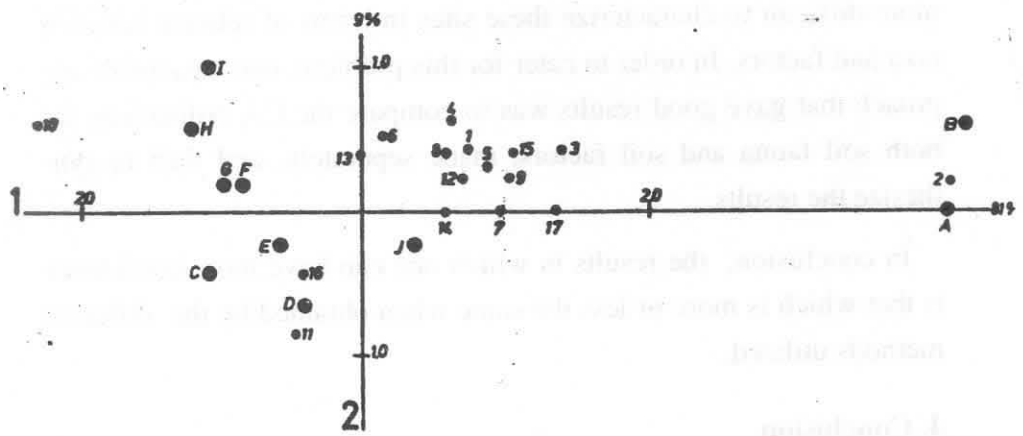

Fig.6. Spectral mapping ordination of the data set of table 1.(For explanation of symbols, see legend of Fig.1).

For the site/taxa data set (Table 1), the best ordinatiorn method utilized was CA. However, SM and DCA gave also good results, whereas PCA gave the least satisfactory result.

For the soil factors data set {Table2) SM gave very good results.

A combined data set from both soil fauna and soil factors was also treated by SM and CA (With wisconsin double standardization [6]) SM gave somewhat satisfactory results, whereas CA gave less satisfactory results. For the combined data set,we notice that the cloud of the soil factors, on the ordination graph, has a tendency to be well separated from the soil fauna taxa cloud in both treatment. It is then more difficult to characterize these sites in terms of relation between taxa and factors. In order to cater for this problem, one reasonable approach that gave good results was to compare the CA ordinations for both soil fauna and soil factors, made separately, and then to synthesize the results.

In conclusion, the results in which one can have more confidence is that which is more or less the same when obtained by the different methods utilized.

4. Conclusion

For the site/taxa data set, CA and SM gave more or less comparable results, with each revealing particular aspects of the nature of the data . A somewhat less satisfactory result was obtained with DCA and the method that gave the least satisfactory results was PCA. This is explained by the fact that PCA does not show the associations between the objects and their descriptors.

For the site/factors data set (Table 2) SM was the method that gave the most satisfactory results,whereas for the combined data set (site/species + factors), which is a set of heterogeneous data types , SM gave somewhat satisfactory results.

To sum up, the series of analyses performed on the same data sets has shown that concordant results obtained from a number of different methods would indicate with more certainty the value of certain species (or taxa) in characterizing sites. Moreover, no single method can give alone the results sought from this study.

Ordination methods used in the present study gave evidence of the main characteristic taxa of soil fauna of the sites that were tested, thus either indicating the species that better characterize the sites or the site in which the species are to be found with higher probability than elsewhere.

In this study, it was also possible to relate the assemblages of soil fauna existing in a site, to the major climatic provinces or zones, to which belong these sites on solely climatological considerations. The fauna of the coastal sand dunes could be shown to form a distinct grouping, characterizing the attenuated arid Mediterranean bioclimatic zone, while the fauna at south Gharbaniat could be shown to be separated and characteristic of the accentuated arid Mediterranean bioclimatic zone. The fauna of the Wadi Assiuty could also be shown to be characteristic of the hyper-arid Saharan bioclimatic province. These distributions could not be discerned from a mere reading of the data table alone.

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References

[1] A.M. Ali, Studies on the animal fauna at AUPA, in: *Assiut University protected area (AUPA) progress report 1985* (Assiu 'University, Assiut, 1985) 23-34.

[2] M.P. Austin, An ordination study of a chalk grassland community, *J. Ecol.* 56 (1968) 739-757.

[3] M.A. Ayyad and M. Abdel-Razek and A. Mehanna, Climatic andvegetation gradients in the Mediterranean desert of Egypt, *Bull. Soc. Bot. Fr.* 131 (1984) 129-143.

[4] J.P. Benzecri, *L'Analyse des Donnees-L'Analyse des Correspondances* (Dunod, Paris, 1973). C. ter Break, Canonical correspondence analysis: a new eigen vector method for multivariate direct gradient analysis, *Ecology* 67 (1986) 1167-1179.

[6] J.R. Bray and J.T. Curtis, An ordination of the upland forestcommunities of southern Wisconsin, Ecol. Monogr. 27 (1957) 325-349.

[7] R.M. Cassie, Multivariate analysis in ecology, Proc. N. Z. Ecol. 16 (1969) 53-57.

[8] R.M. Cassie and A.D. Michael, Fauna and sediments of an intertidal mud flat: a multivariate analysis, *J. Exp. Mar. Biol. Ecol.* 2 (1968) 1-23.

[9] L.J. Cronbach and G.C. Gleser, Assessing Similiarity betweenprofiles, The Psychological Bulletin 50 (1953) 456-473.

[10] S.P. Dagnelie, Introduction a l'analyse statistiques a plusieurs variables, *Biometrie-Proximetrie* 7 (1966) 43-66.

[11] B. Escofier-Cordier, *L'analyse factorielle des correspondances*, Cah. Burl Univ. Rech. Oper. 13 (1969) 25-59.

[12] H.G. Gauch and T.R. Wentworth, Canonical correlation analysis as an ordination technique, *Vegetatio* 33 (1976) 1722

[13] S.I. Ghabbour and Cancela da Fonseca and S.H. Shakir, Differentiation of soil fauna in desert agriculture of the Mariut region, *Biol. Fert. Soils* 1 (1985)9-14.

[14] R. Gittins, *Canonical Analysis* (springler-Verlag, Berlin, Heidelberg, 1985).

(15] M.J. Greenacre, *Theory and applications of correspondence analysis* (Academic Press, London, 1984).

[16] M.O. Hill, *Decorana-A FORTRAN program for detrended correspondence analysis and reciprocal averaging* (Ithaca, New York, Cornell University Press, 1979).

[17] M.O. Hill and H.G. Gauch, Detrended correspondence analysis an improved ordination technique, *Vegetatio* 42 (1980) 47-58

[18] M. Hotelling, analysis of a complex statistical variables into principal components, *J. Educ. Psychol.* 24 (1933) 417-441 .

[19] P.J. Lewi, The use of multivariate statistics in industrial Pharmacology, *Pharmac. Ther.* B. 3 (1978 J 481-537.

[20] *Multivariate Data Analysis Program*, Program description and operations manual, SB11-5390-0 (IBM Corp., 1980).

[21] E.C. Pielou, *Mathematical Ecology* (Wiley-Interscience, New York, 1977).

[22] T. Rosswall, *Nitrogen cycling in west African ecosystems*, (SCOPE/UNEP Int' al Nitrogen Unit, The Royal Swedish Acad. Sci., Stockholm, 1980).

بعض مظاهر الأنواع الهامة من حيوانات التربة في صحراء ساحلية أفرومتوسطية

٦ - دراسات عن التحليل الإحصائي لبيانات عشائر حيوانات التربة باستخدام الأساليب التنظيمية

تأليف

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ملخص

عولجت فى هذه الورقة مجموعتان من بيانات الكثافة العشائرية لحيوانات التربة وكذلك البيانات الخاصة بالعوامل الأيكولوجية الخاصة بالتربة التى وجدت فيها هذه الحيوانات ، من منطقة الصحراء الأفرومتوسطية الجافة غرب الإسكندرية ، وأضيفت إليها مجموعة أخرى من البيانات من الصحراء الداخلية شديدة الجفاف فى وادى الأسيوطى ، وثم تحليل هذه البيانات إحصائيا باستخدام بعض أساليب التحليل الإحصائى شائعة الإستخدام ، وهى تحليل المكونات الرئيسية ، والتحليل التوافقى للعوامل ، والتحليل التوافقى عديم الاتجاه ، وأخيراً التخريط الطيفى ، وذلك من أجل التعرف على القيمة النوعية لكل واحد من هذه الأساليب بالنسبة إلى مدرك توصيف وتشخيص المواقع عن طريق أنماط ما تحويه تلك المواقع من عشائر حيوانات

التربة . وقد قورنت الأساليب التنظيمية التى استخدمت هذا فيما بينها حسب مزاياها النسبية لحل هذه المشكلة العلمية موضع النظر . وقد جاءت أفضل النتائج باستخدام أسلوبى التحليل التوافقى والتخريط الطيفى . وقد أوضحت الدراسة أن النتائج المتوافقة التى يتحصل عليها باستخدام عدد من الأساليب ، والتى تطبق على قواعد البيانات ذاتها ، تؤدى إلى تؤكيد أكبر لقيمة بعض أنواع حيوانات التربة ولدورها فى توصيف وتشخيص موقع بعينه .